

Frame 0267, on January 8, 2004. A copy of the Patent Assignment is annexed hereto as Exhibit A.

4. I am aware that Application No. 10/046,426 claims benefit of U.S. Provisional Application Ser. No. 60/296,598, filed June 7, 2001.

5. I invented the subject matter of Application No. 10/046,426, including at least one of the claims therein, with Scott Elman, Keng Moy and Vadim Boguslavskiy, and in accordance with our invention, we reduced the invention to practice prior to May 5, 1999.

6. I am familiar with the prosecution of Application No. 10/046,426, including the Office Action mailed August 23, 2004. In particular, this Office Action includes a rejection based in part upon U.S. Patent Application Publication No. U.S. 2002/0068870 to Noorbakhsh et al. (the '870 published application).

7. I make this Declaration under 37 C.F.R. § 1.131 in order to present a showing of facts establishing a reduction to practice of the invention claimed in Application No. 10/046,426 in this country prior to May 5, 1999, which is the earliest effective filing date of the '870 published application.

8. All of the facts described herein took place in the United States.

9. Annexed hereto is Exhibit B, which is a true copy of an Emcore Patent Disclosure, the date of which has been redacted, but which predates May 5, 1999. The disclosure details a reactor for epitaxial deposition having a cylindrical shutter

with an internal cavity for receiving a coolant, which discloses each and every feature of the reactor as claimed in at least one pending claim of Application No. 10/046,426. As set forth in the patent disclosure, my invention is described as a reactor for growing epitaxial layers including an airtight reaction chamber having a passthrough opening for inserting and removing wafer carriers from the reaction chamber, and a cylindrical shutter located inside the reaction chamber for selectively closing the passthrough opening, the cylindrical shutter being movable between a first position for closing the passthrough opening and a second position for opening the passthrough opening, whereby the cylindrical shutter has an internal cavity adapted to receive a cooling fluid.

10. Annexed hereto is Exhibit C, which is a true copy of an Emcore print, the date of which has been redacted, but which predates May 5, 1999. The print details a cylindrical shutter having an internal cavity for receiving a coolant.

11. Prior to May 5, 1999, we thus invented and actually reduced to practice a reactor for growing epitaxial layers having a cylindrical shutter with an internal cavity adapted to receive a cooling fluid.

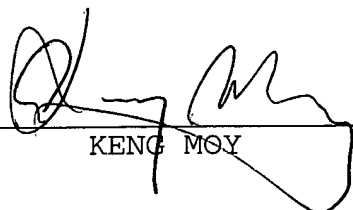
12. It is submitted that the foregoing presentation of facts and supporting documentation establishes the completion of Applicants' claimed invention and that such completion predates May 5, 1999.

13. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on

information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

9/10/2004

Date


KENG MOY

Attachments:

- Exhibit A - Merger Document
- Exhibit B - Emcore Corporation Patent Disclosure
- Exhibit C - Emcore Corporation Print

515489_1.DOC

Exhibit A - Merger Document

3.0 - 069

Docket No.: F53342

FORM PTO-1595 (Modified)
(Rev. 03-01)
OMB No. 0551-0027 (exp. 3/31/2002)
P08/REV03

RECORDATION FORM COVER SHEET

U.S. DEPARTMENT OF COMMERCE
Patent and Trademark Office

PATENTS ONLY

Tab settings → → → ▼ ▼ ▼ ▼ ▼ ▼ ▼

To the Director of the United States Patent and Trademark Office: Please record the attached original documents or copy thereof.

1. Name of conveying party(ies):
EMCORE Corporation

Additional names(s) of conveying party(ies)

☒ Yes ☐ No

3. Nature of conveyance:

- ☒ Assignment ☐ Merger
☐ Security Agreement ☐ Change of Name
☐ Other _____

Execution Date: **December 22, 2003**

2. Name and address of receiving party(ies):

Name: **Veeco Instruments Inc.**

Internal Address: _____

Street Address: _____

City: **Woodbury** State: **NY** ZIP: **11797**Additional name(s) & address(es) attached? ☐ Yes ☒ No

4. Application number(s) or patent numbers(s):

If this document is being filed together with a new application, the execution date of the application is: _____

A. Patent Application No.(s)

09/619,254 60/514,959
10/046,426
10/304,646
10/268,464

B. Patent No.(s)

4,714,091	5,336,324	5,835,678
4,772,356	5,544,618	6,001,183
4,838,983	5,759,281	6,080,241
4,969,416	5,835,677	6,197,121

Additional numbers attached? ☒ Yes ☐ No

5. Name and address of party to whom correspondence concerning document should be mailed:

Name: **Philip Braginsky**

Internal Address: _____

Street Address: _____

City: **Garden City** State: **NY** ZIP: **11530**6. Total number of applications and patents involved: **22**7. Total fee (37 CFR 3.41):.....\$ **880.00**☐ Enclosed - Any excess or insufficiency should be credited or debited to deposit account☒ Authorized to be charged to deposit account

8. Deposit account number:

19-1013

(Attach duplicate copy of this page if paying by deposit account)

DO NOT USE THIS SPACE

9. Statement and signature.

To the best of my knowledge and belief, the foregoing information is true and correct and any attached copy is a true copy of the original document.

Philip Braginsky, 40,527

Name of Person Signing

Signature

January 8, 2004

Date

Total number of pages including cover sheet, attachments, and document: **6**

Mail documents to be recorded with required cover sheet information to:
Mail Stop Assignment Recordation Services

Director of the United States Patent and Trademark Office, P.O. Box 1450

PATENT

REEL: 014242 FRAME: 0265

700059763

CH \$880.00 191013 09619254

Additional patent numbers:

6,368,404

6,349,270

6,492,625

6,506,252

6,547,876

Patent Assignment

WHEREAS, EMCORE Corporation (hereinafter, "Assignor"), a New Jersey corporation with a place of business at 145 Belmont Drive, Somerset, NJ is the owner of rights in certain patents and/or patent applications listed in the attached Schedule, and the inventions disclosed and claimed therein (the "Patents");

WHEREAS, Veeco Instruments Inc. (hereinafter, "Assignee"), a corporation organized and existing under the laws of the State of Delaware with offices at 100 Sunnyside Blvd., Suite B, Woodbury, NY 11797-2902, United States of America, desires to acquire Assignor's entire right, title, and interest in and to the Patents; and

WHEREAS, Assignor and Assignee have entered into an Intellectual Property Agreement pursuant to which Assignor has agreed to assign certain proprietary technology, including the Patents, to Assignee.

NOW THEREFORE, effective immediately by this document, and for good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, Assignor does hereby sell, assign and transfer to Assignee, and its successors and assigns, Assignor's entire right, title, and interest, in the United States and all foreign countries, in the Patents, and all continuations, divisions, extensions, reexaminations, reissues, and substitutes thereof, rights of priority under the International Convention for the Protection of Industrial Property, the Inter-American Convention Relating to Patents, Designs and Industrial Models, and any other international agreements to which the United States adheres, and in and to all income, royalties, damages, claims, and payments now or hereafter due or payable with respect thereto, and in and to all causes of action (either in law or in equity) and the right to sue, counterclaim, and recover for past, present, and future infringement of the rights assigned to Assignee hereunder.

Assignor hereby agrees to execute any papers and to perform such other proper acts as reasonably necessary to secure to Assignee or to its successors or assigns, the rights, title and interest hereby transferred.

WHEREFORE, Assignor has duly executed this Patent Assignment on the date indicated below.

("Assignor")

By:



Howard Brodie
Vice President & General Counsel

Date: December 22, 2003

[STATE OF New Jersey]

COUNTY OF Monmouth

On this 22 day of December 2003 before me, a Notary Public in and for Monmouth in the State of New Jersey, personally appeared Howard Brodie and being duly sworn, averred that, being duly authorized, he executed the foregoing Assignment as his free and voluntary act for the uses and purposes therein set forth.

NOTARY PUBLIC

My Commission Expires: 5/1/2007

SILVIA GENTILE
NOTARY PUBLIC OF NEW JERSEY
My Commission Expires May 1, 2007

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PATENT
REEL: 014242 FRAME: 0268

U.S. Patent No. 6,506,252
Chinese Patent Appln. No. 01822507.1
European Patent Appln. No. 01964250.3
Japanese Patent Appln. No. 2002-562804
Korean Patent Appln. No. 10-2003-7010387

SUSCEPTORLESS REACTOR FOR GROWING
EPITAXIAL LAYERS ON WAFERS BY CVD

U.S. Patent No. 6,547,876

APPARATUS FOR GROWING EPITAXIAL
LAYERS ON WAFERS BY CHEMICAL VAPOR
DEPOSITION

U.S. Patent Appln. No. 09/619,254
European Patent Appln. No. 00952166.7
Japanese Patent Appln. No. 512955/2001
Korean Patent Appln. No. 2002-701052
Taiwan Patent No. NI-154647

APPARATUS FOR GROWING EPITAXIAL
LAYERS ON WAFERS USING LOW PRESSURE
INTERFACE AND METHODS THEREOF

U.S. Patent Appln. No. 10/046,426

REACTOR HAVING A MOVABLE SHUTTER

U.S. Patent Appln. No. 10/304,646
U.S. Patent Appln. No. 10/268,464

SUSCEPTORLESS REACTOR FOR GROWING
EPITAXIAL LAYERS ON WAFERS BY
CHEMICAL VAPOR DEPOSITION

U.S. Patent Appln. No. 09/619,254

APPARATUS FOR GROWING EPITAXIAL
LAYERS ON WAFERS USING LOW PRESSURE
INTERFACE AND METHODS THEREFOR

U.S. Provisional Appln. No. 60/514,959

WAFER CARRIER FOR GROWING GaN
WAFERS

PCT/US03/26112
Taiwan Patent Appln. No. 092125071

ALKYL PUSH FLOW FOR VERTICAL FLOW
ROTATING DISK REACTORS

N/A

METHOD AND DEVICE FOR WAFER AND
CARRIER CONTROL DURING MOCVD OF
GaN RELATED MATERIALS

Patent Schedule

U.S. Patent No. 4,714,091
Japanese Patent No. 1758220

MODULAR GAS HANDLING APPARATUS

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U.S. Patent No. 4,838,983
U.S. Patent No. 4,969,416

GAS TREATMENT APPARATUS AND METHOD

U.S. Patent No. 5,336,324
U.S. Patent No. 5,544,618

APPARATUS FOR DEPOSITING A COATING
ON A SUBSTRATE

U.S. Patent No. 5,759,281

CVD REACTOR FOR UNIFORM HEATING
WITH RADIANT HEATING ELEMENTS

U.S. Patent No. 5,835,677
U.S. Patent No. 5,835,678

LIQUID VAPORIZER SYSTEM AND METHOD

U.S. Patent No. 6,001,183

WAFER CARRIERS FOR EPITAXIAL
GROWTH PROCESSES

U.S. Patent No. 6,080,241

CHEMICAL VAPOR DEPOSITIONS CHAMBER
HAVING AN ADJUSTABLE FLOW FLANGE

U.S. Patent No. 6,197,121

CHEMICAL VAPOR DEPOSITION
APPARATUS

U.S. Patent No. 6,368,404

INDUCTION HEATING CHEMICAL VAPOR
DEPOSITION REACTOR

U.S. Patent No. 6,349,270

METHOD AND APPARATUS FOR
MEASURING THE TEMPERATURE OF
OBJECTS ON A FAST MOVING HOLDER

U.S. Patent No. 6,492,625
Chinese Patent Appln. No. 01819511.3
European Patent Appln. No. 01957492.0
Japanese Patent Appln. No. 2002-530254
Korean Patent Appln. No. 10-2003-7003837

APPARATUS AND METHOD FOR
CONTROLLING TEMPERATURE
UNIFORMITY OF SUBSTRATES

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PATENT
REEL: 014242 FRAME: 0269

Exhibit B - Emcore Corporation Patent Disclosure

REACTOR FOR HIGH TEMPERATURE EPITAXIAL DEPOSITION

EMCORE Corporation, 145 Belmont Drive, Somerset, NJ 08873

Authors: Keng Moy, Scott Elman, Vadim Boguslavskiy, Alex Gurary

PATENT DISCLOSURE

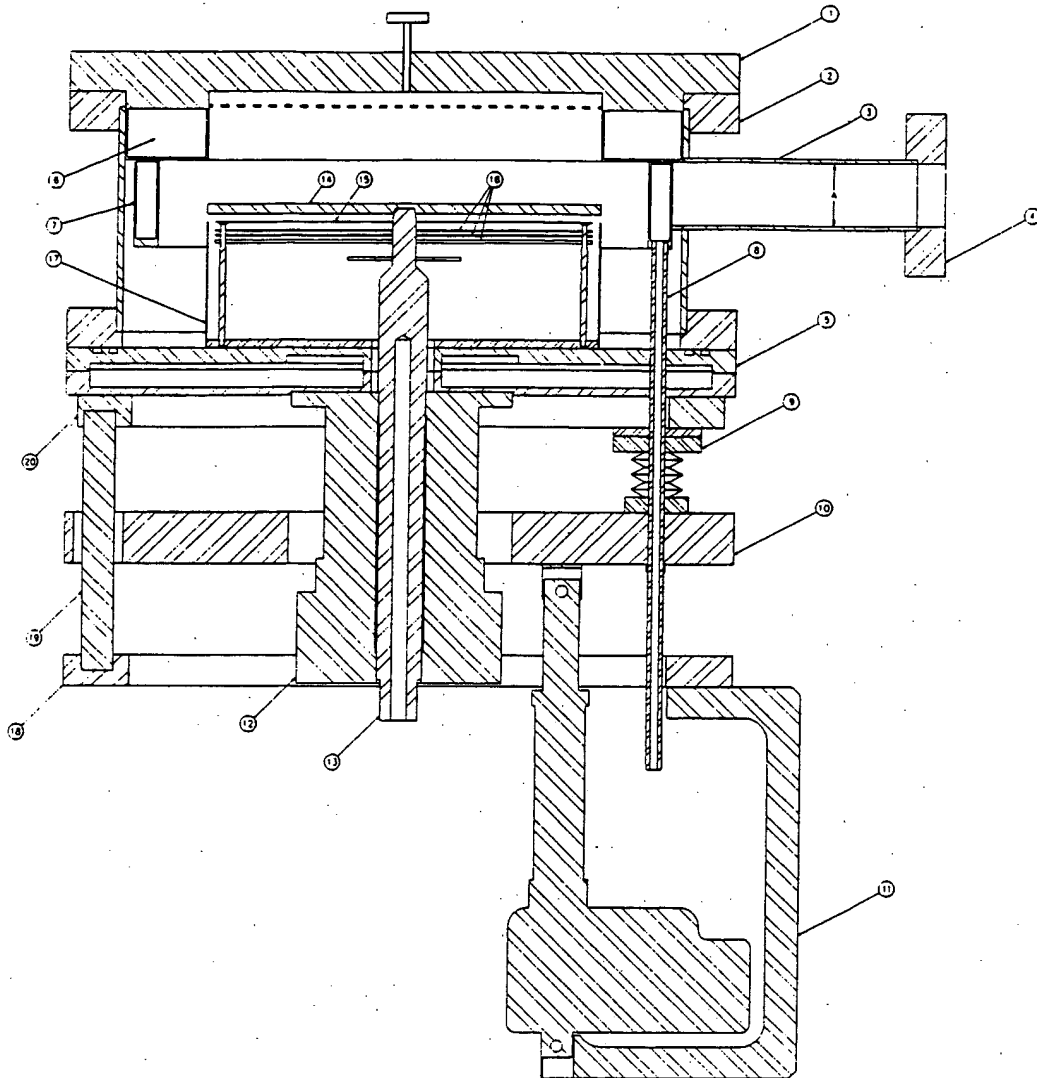


Figure 1. Schematics of the reactor for high temperature epitaxial deposition

Abstract.

Object of the invention is a reactor for high temperature epitaxial deposition with mechanism for wafer carrier transfer in and out reactor which do not produce disturbance in the axisymmetric uniformity of thermal and flow field inside reactor and, hence, provides for extremely uniform epitaxial deposition. Invention is applicable preferably to axisymmetric reactor for epitaxial deposition of SiC (1600 C) and GaN (1100 C). Additionally invention is applicable for epitaxial reactor based on the high speed vertical rotating disk technology.

Background of the invention.

Most of production level epitaxial deposition reactors have a cylindrical shape with opening on the side wall to transfer wafer carriers in and out of the reactor. Opening on the side is connected through the gate valve with load lock which allows the reactor to be open each run while maintaining a low level of contamination in the reactor environment required for the advanced epitaxial deposition. During the deposition run the opening on the wall is covered by the special movable shutter with surface larger than opening to prevent gate valve overheating and particles formation. Unfortunately shutter also provides disturbance in the process flow dynamic (because to provide its movement shutter could not perfectly fit dimensions of the opening in the wall) and disturbance in the reactor thermal dynamic (because heat flow from the shutter is unavoidably different from the wall). Especially significant is thermal disturbance from the shutter in the reactor for high temperature epitaxial deposition (SiC - 1600 C, GaN - 1100 C) where reactor wall are usually water cooled while shutter is not. Because shutter components are logically located approximately on the wafer carrier level, the disturbance from it can have a significant negative effect on the deposition process which is extremely sensitive to uniformity of reactants flow and temperature distribution inside process reactor.

Description of the invention.

Invention is schematically shown (but not limited to) in figure 1. Cylindrical process reactor 2 is made of stainless steel. Reactants are introduced inside reactor 2 through the shower head type water cooled injector flange 1. Water cooled element 6 confine reactants flow to increase deposition efficiency. Wafer carrier 14 with substrates (Si, GaAs, Ge, InP, SiC, sapphire, etc.) for epitaxial deposition can be transferred by special vacuum robot (not shown in figure) through the passthrough 3 with flange 4 connected to gate valve (not shown) that separate reactor environment. Wafer carrier 14 is heated by the radiant heating element(s) 15 which high heating efficiency is provided by three horizontal heat shields 16 and vertical cylindrical heat shield 17. Wafer carrier is supported and spanned by the water cooled spindle 13 sealed from outside by commercially available vacuum rotary feedthrough (in most cases ferrofluidic type) 12 with implemented electrical motor. Process reactor 2 and rotary feedthrough 12 are fixed on water cooled base plate 5.

Passthrough 3 opening is covered by cylindrical shutter 7 with internal cavity for water cooling. Shutter 7 is located on at least two tubing 8 (only one is shown in figure) which is sealed to the reactor based plate 5 using bellow 9. Another end of the tubing 8 is connected to the moveable plate 10 installed using linear motion guide 19 connected through the spacer 20 to the reactor base plate 5. Plate 10 can move up and down by electro-mechanical actuator 11 fixed using stationary plate 18, guide 19, and spacer 20 on the reactor base plate 5. Cooling water is supplied to moveable shutter 7 through the flexible tubing (not shown) connected with the first tube 8, second tube 8 provide for cooling water return.

Movable tubing allows the water cooled shutter 7 to close passthrough 3 opening during epitaxial deposition run. At this time water cooled shutter 7 provides for uniform temperature and flow field around wafer carrier 14 that are required for uniform epitaxial deposition. When deposition run is over, the water cooled shutter 7 is moved down (by force transferred through tubing 8 from electro-mechanical actuator 11) and open passthrough 3 to transfer old carrier 14 from the reactor and new carrier 14 (not shown) in to the reactor.

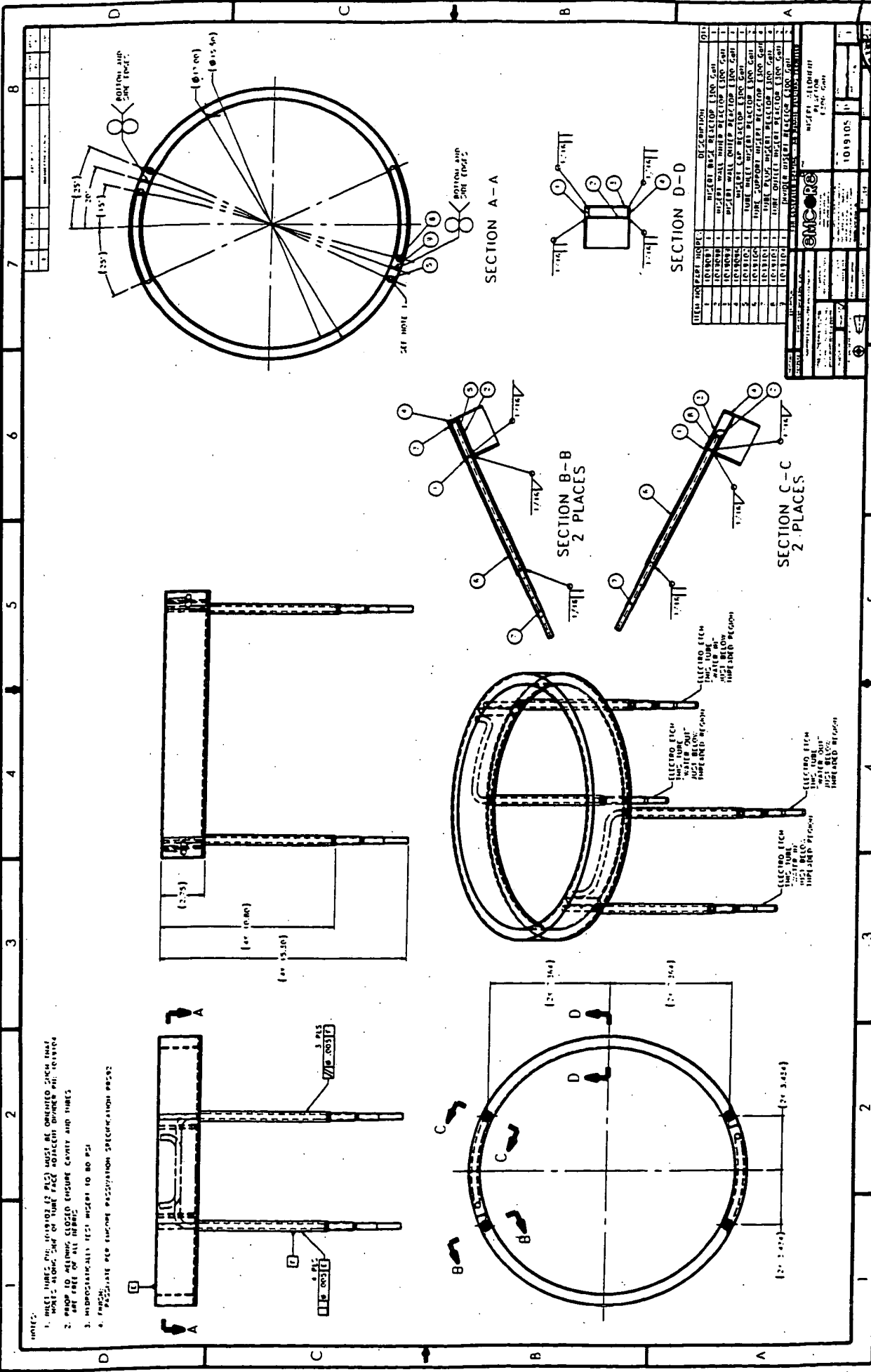
History of the invention:

Water cooled cylindrical shutter was independently suggested and implemented by Alex Gurary and Vadim Boguslavskiy in D75 shell reactor on system 6; and by Keng Moy and Scott Elman in E300 GaN system. No system with water cooled cylindrical shutter was sold so far and this design was not presented in papers or on the conferences.

Why we should apply for this invention:

We will protect IP on new important for EMCORE product – E300 GaN system. We strongly believe that successful implementation of this system is largely due to uniform flow and thermal field achieved because of cylindrical water cooled shutter implementation is this system. In future we can expect use such a shutter on new generation of EMCORE's systems.

Exhibit C - Emcore Corporation Print



PATENT
VEECO 3.0-069

the United States Patent and Trademark Office at Reel 014242, Frame 0267, on January 8, 2004. A copy of the Patent Assignment is annexed hereto as Exhibit A.

4. I am aware that Application No. 10/046,426 claims benefit of U.S. Provisional Application Ser. No. 60/296,598, filed June 7, 2001.

5. I invented the subject matter of Application No. 10/046,426, including at least one of the claims therein, with Scott Elman, Keng Moy and Vadim Boguslavskiy, and in accordance with our invention, we reduced the invention to practice prior to May 5, 1999.

6. I am familiar with the prosecution of Application No. 10/046,426, including the Office Action mailed August 23, 2004. In particular, this Office Action includes a rejection based in part upon U.S. Patent Application Publication No. U.S. 2002/0068870 to Noorbakhsh et al. (the '870 published application).

7. I make this Declaration under 37 C.F.R. § 1.131 in order to present a showing of facts establishing a reduction to practice of the invention claimed in Application No. 10/046,426 in this country prior to May 5, 1999, which is the earliest effective filing date of the '870 published application.

8. All of the facts described herein took place in the United States.

9. Annexed hereto is Exhibit B, which is a true copy of an Emcore Patent Disclosure, the date of which has been redacted, but which predates May 5, 1999. The disclosure details

a reactor for epitaxial deposition having a cylindrical shutter with an internal cavity for receiving a coolant, which discloses each and every feature of the reactor as claimed in at least one pending claim of Application No. 10/046,426. As set forth in the patent disclosure, my invention is described as a reactor for growing epitaxial layers including an airtight reaction chamber having a passthrough opening for inserting and removing wafer carriers from the reaction chamber, and a cylindrical shutter located inside the reaction chamber for selectively closing the passthrough opening, the cylindrical shutter being movable between a first position for closing the passthrough opening and a second position for opening the passthrough opening, whereby the cylindrical shutter has an internal cavity adapted to receive a cooling fluid.

10. Annexed hereto is Exhibit C, which is a true copy of an Emcore print, the date of which has been redacted, but which predates May 5, 1999. The print details a cylindrical shutter having an internal cavity for receiving a coolant.

11. Prior to May 5, 1999, we thus invented and actually reduced to practice a reactor for growing epitaxial layers having a cylindrical shutter with an internal cavity adapted to receive a cooling fluid.

12. It is submitted that the foregoing presentation of facts and supporting documentation establishes the completion of Applicants' claimed invention and that such completion predates May 5, 1999.

13. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

9/20/2004
Date

V. Boguslavskiy
VADIM BOGUSLAVSKIY

Attachments:

- Exhibit A - Merger Document
- Exhibit B - Emcore Corporation Patent Disclosure
- Exhibit C - Emcore Corporation Print

515487_1.DOC

Exhibit A - Merger Document

3.0 - 069

Docket No.: F53342

FORM PTO-1595 (Modified)
(Rev. 03-01)
OMB No. 0651-0027 (exp. 3/31/2002)
P08/REV03

RECORDATION FORM COVER SHEET

U.S. DEPARTMENT OF COMMERCE
Patent and Trademark Office

PATENTS ONLY

Tab settings → → → ▼ ▼ ▼ ▼ ▼ ▼ ▼

To the Director of the United States Patent and Trademark Office: Please record the attached original documents or copy thereof.

1. Name of conveying party(ies):
EMCORE Corporation

Additional names(s) of conveying party(ies)

☒ Yes ☐ No

3. Nature of conveyance:

☒ Assignment☐ Merger☐ Security Agreement☐ Change of Name☐ OtherExecution Date: **December 22, 2003**

2. Name and address of receiving party(ies):

Name: **Veeco Instruments Inc.**

Internal Address:

Street Address:

City: **Woodbury** State: **NY** ZIP: **11797**Additional name(s) & address(es) attached? ☐ Yes ☒ No

4. Application number(s) or patent numbers(s):

If this document is being filed together with a new application, the execution date of the application is:

A. Patent Application No.(s)

09/619,254

60/514,959

10/046,426

10/304,646

10/268,464

B. Patent No.(s)

4,714,091

5,336,324

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4,838,983

5,759,281

6,080,241

4,969,416

5,835,677

6,197,121

Additional numbers attached? ☒ Yes ☐ No

5. Name and address of party to whom correspondence concerning document should be mailed:

Name: **Philip Braginsky**

Internal Address:

Street Address:

City: **Garden City** State: **NY** ZIP: **11530**6. Total number of applications and patents involved: **22**7. Total fee (37 CFR 3.41):.....\$ **880.00**☐ Enclosed - Any excess or insufficiency should be credited or debited to deposit account☒ Authorized to be charged to deposit account

8. Deposit account number:

19-1013

(Attach duplicate copy of this page if paying by deposit account)

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9. Statement and signature.

To the best of my knowledge and belief, the foregoing information is true and correct and any attached copy is a true copy of the original document.

Philip Braginsky, 40,527

Name of Person Signing

Signature

January 8, 2004

Date

Total number of pages including cover sheet, attachments, and document: **6**

Mail documents to be recorded with required cover sheet information to:
Mail Stop Assignment Recordation Services

Director of the United States Patent and Trademark Office, P.O. Box 1450

700059763

PATENT

REEL: 014242 FRAME: 0265

CH \$880.00 191013 09619254

Additional patent numbers:

6,368,404
6,349,270
6,492,625
6,506,252
6,547,876

Patent Assignment

WHEREAS, **EMCORE Corporation** (hereinafter, "Assignor"), a New Jersey corporation with a place of business at 145 Belmont Drive, Somerset, NJ is the owner of rights in certain patents and/or patent applications listed in the attached Schedule, and the inventions disclosed and claimed therein (the "Patents");

WHEREAS, **Veeco Instruments Inc.** (hereinafter, "Assignee"), a corporation organized and existing under the laws of the State of Delaware with offices at 100 Sunnyside Blvd., Suite B, Woodbury, NY 11797-2902, United States of America, desires to acquire Assignor's entire right, title, and interest in and to the Patents; and

WHEREAS, Assignor and Assignee have entered into an Intellectual Property Agreement pursuant to which Assignor has agreed to assign certain proprietary technology, including the Patents, to Assignee.

NOW THEREFORE, effective immediately by this document, and for good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, Assignor does hereby sell, assign and transfer to Assignee, and its successors and assigns, Assignor's entire right, title, and interest, in the United States and all foreign countries, in the Patents, and all continuations, divisions, extensions, reexaminations, reissues, and substitutes thereof, rights of priority under the International Convention for the Protection of Industrial Property, the Inter-American Convention Relating to Patents, Designs and Industrial Models, and any other international agreements to which the United States adheres, and in and to all income, royalties, damages, claims, and payments now or hereafter due or payable with respect thereto, and in and to all causes of action (either in law or in equity) and the right to sue, counterclaim, and recover for past, present, and future infringement of the rights assigned to Assignee hereunder.

Assignor hereby agrees to execute any papers and to perform such other proper acts as reasonably necessary to secure to Assignee or to its successors or assigns, the rights, title and interest hereby transferred.

WHEREFORE, Assignor has duly executed this Patent Assignment on the date indicated below.

("Assignor")

By:



Howard Brodie
Vice President & General Counsel

Date: December 22, 2003

[STATE OF New Jersey]

COUNTY OF Monmouth)

On this 22 day of December 2003 before me, a Notary Public in and for Monmouth in the State of New Jersey, personally appeared Howard Brodie and being duly sworn, averred that, being duly authorized, he executed the foregoing Assignment as his free and voluntary act for the uses and purposes therein set forth.

NOTARY PUBLIC

My Commission Expires: 5/1/2007]

SILVIA GENTILE
NOTARY PUBLIC OF NEW JERSEY
My Commission Expires May 1, 2007

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PATENT
REEL: 014242 FRAME: 0268

U.S. Patent No. 6,506,252
Chinese Patent Appln. No. 01822507.1
European Patent Appln. No. 01964250.3
Japanese Patent Appln. No. 2002-562804
Korean Patent Appln. No. 10-2003-7010387

SUSCEPTORLESS REACTOR FOR GROWING
EPITAXIAL LAYERS ON WAFERS BY CVD

U.S. Patent No. 6,547,876

APPARATUS FOR GROWING EPITAXIAL
LAYERS ON WAFERS BY CHEMICAL VAPOR
DEPOSITION

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European Patent Appln. No. 00952166.7
Japanese Patent Appln. No. 512955/2001
Korean Patent Appln. No. 2002-701052
Taiwan Patent No. NI-154647

APPARATUS FOR GROWING EPITAXIAL
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ROTATING DISK REACTORS

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Japanese Patent No. 1758220

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U.S. Patent No. 5,544,618

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ON A SUBSTRATE

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WITH RADIANT HEATING ELEMENTS

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U.S. Patent No. 6,492,625
Chinese Patent Appln. No. 01819511.3
European Patent Appln. No. 01957492.0
Japanese Patent Appln. No. 2002-530254
Korean Patent Appln. No. 10-2003-7003837

APPARATUS AND METHOD FOR
CONTROLLING TEMPERATURE
UNIFORMITY OF SUBSTRATES

H:\work\1714\F53342\Misc\Patent Schedule.doc

PATENT
REEL: 014242 FRAME: 0269

Exhibit B - Emcore Corporation Patent Disclosure

REACTOR FOR HIGH TEMPERATURE EPITAXIAL DEPOSITION

EMCORE Corporation, 145 Belmont Drive, Somerset, NJ 08873

Authors: Keng Moy, Scott Elman, Vadim Boguslavskiy, Alex Gurary

PATENT DISCLOSURE

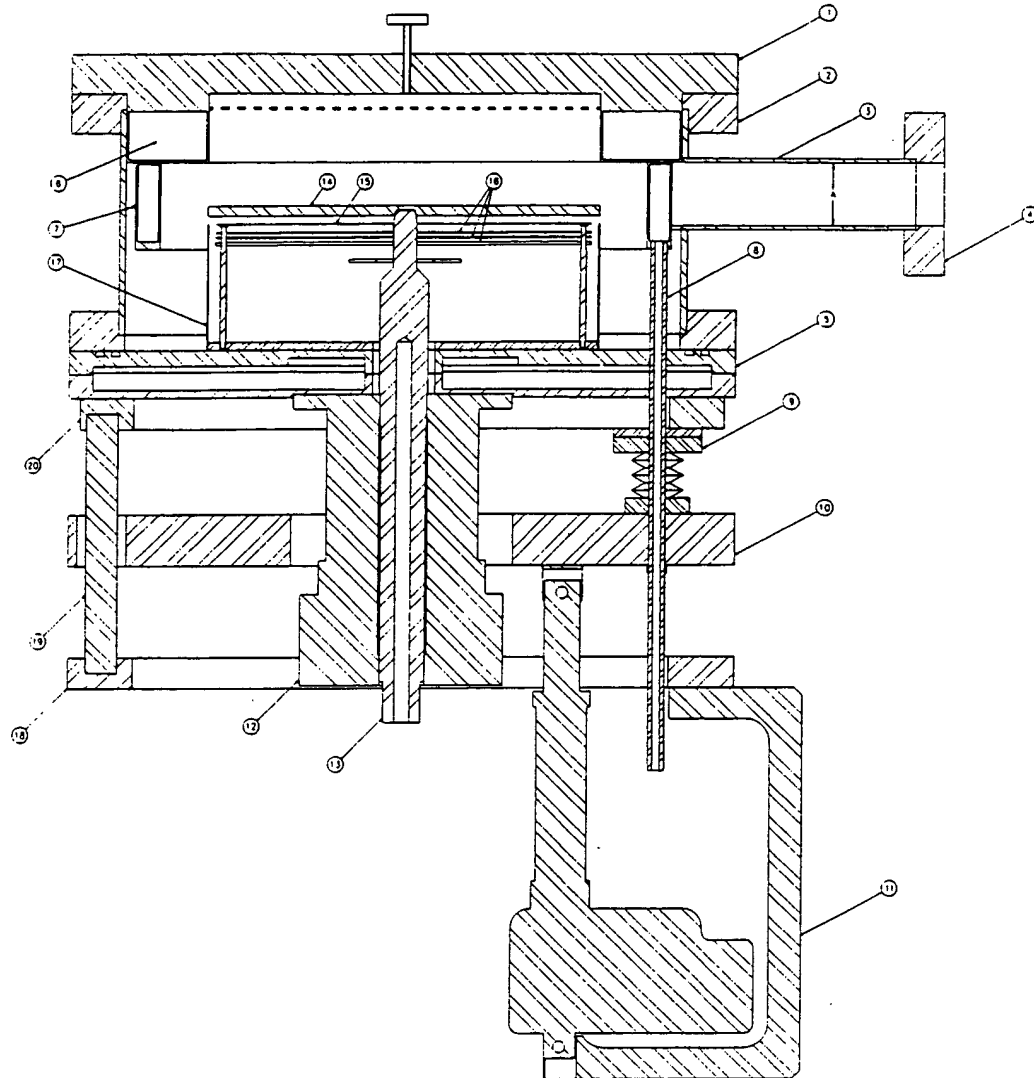


Figure 1. Schematics of the reactor for high temperature epitaxial deposition

Abstract.

Object of the invention is a reactor for high temperature epitaxial deposition with mechanism for wafer carrier transfer in and out reactor which do not produce disturbance in the axisymmetric uniformity of thermal and flow field inside reactor and, hence, provides for extremely uniform epitaxial deposition. Invention is applicable preferably to axisymmetric reactor for epitaxial deposition of SiC (1600 C) and GaN (1100 C). Additionally invention is applicable for epitaxial reactor based on the high speed vertical rotating disk technology.

Background of the invention.

Most of production level epitaxial deposition reactors have a cylindrical shape with opening on the side wall to transfer wafer carriers in and out of the reactor. Opening on the side is connected through the gate valve with load lock which allows the reactor to be open each run while maintaining a low level of contamination in the reactor environment required for the advanced epitaxial deposition. During the deposition run the opening on the wall is covered by the special movable shutter with surface larger than opening to prevent gate valve overheating and particles formation. Unfortunately shutter also provides disturbance in the process flow dynamic (because to provide its movement shutter could not perfectly fit dimensions of the opening in the wall) and disturbance in the reactor thermal dynamic (because heat flow from the shutter is unavoidably different from the wall). Especially significant is thermal disturbance from the shutter in the reactor for high temperature epitaxial deposition (SiC – 1600 C, GaN – 1100 C) where reactor wall are usually water cooled while shutter is not. Because shutter components are logically located approximately on the wafer carrier level, the disturbance from it can have a significant negative effect on the deposition process which is extremely sensitive to uniformity of reactants flow and temperature distribution inside process reactor.

Description of the invention.

Invention is schematically shown (but not limited to) in figure 1. Cylindrical process reactor 2 is made of stainless steel. Reactants are introduced inside reactor 2 through the shower head type water cooled injector flange 1. Water cooled element 6 confine reactants flow to increase deposition efficiency. Wafer carrier 14 with substrates (Si, GaAs, Ge, InP, SiC, sapphire, etc.) for epitaxial deposition can be transferred by special vacuum robot (not shown in figure) through the passthrough 3 with flange 4 connected to gate valve (not shown) that separate reactor environment. Wafer carrier 14 is heated by the radiant heating element(s) 15 which high heating efficiency is provided by three horizontal heat shields 16 and vertical cylindrical heat shield 17. Wafer carrier is supported and spanned by the water cooled spindle 13 sealed from outside by commercially available vacuum rotary feedthrough (in most cases ferrofluidic type) 12 with implemented electrical motor. Process reactor 2 and rotary feedthrough 12 are fixed on water cooled base plate 5.

Passthrough 3 opening is covered by cylindrical shutter 7 with internal cavity for water cooling. Shutter 7 is located on at least two tubing 8 (only one is shown in figure) which is sealed to the reactor based plate 5 using bellow 9. Another end of the tubing 8 is connected to the moveable plate 10 installed using linear motion guide 19 connected through the spacer 20 to the reactor base plate 5. Plate 10 can move up and down by electro-mechanical actuator 11 fixed using stationary plate 18, guide 19, and spacer 20 on the reactor base plate 5. Cooling water is supplied to moveable shutter 7 through the flexible tubing (not shown) connected with the first tube 8, second tube 8 provide for cooling water return.

Movable tubing allows the water cooled shutter 7 to close passthrough 3 opening during epitaxial deposition run. At this time water cooled shutter 7 provides for uniform temperature and flow field around wafer carrier 14 that are required for uniform epitaxial deposition. When deposition run is over, the water cooled shutter 7 is moved down (by force transferred through tubing 8 from electro-mechanical actuator 11) and open passthrough 3 to transfer old carrier 14 from the reactor and new carrier 14 (not shown) in to the reactor.

History of the invention:

Water cooled cylindrical shutter was independently suggested and implemented by Alex Gurary and Vadim Boguslavskiy in D75 shell reactor on system 6; and by Keng Moy and Scott Elman in E300 GaN system. No system with water cooled cylindrical shutter was sold so far and this design was not presented in papers or on the conferences.

Why we should apply for this invention:

We will protect IP on new important for EMCORE product – E300 GaN system. We strongly believe that successful implementation of this system is largely due to uniform flow and thermal field achieved because of cylindrical water cooled shutter implementation is this system. In future we can expect use such a shutter on new generation of EMCORE's systems.

Exhibit C - Emcore Corporation Print

PATENT
VEECO 3.0-069

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of	:	
Gurary et al.	:	
	:	Group Art Unit: 1763
Application No. 10/046,426	:	
	:	Examiner: K. Moore
Filed: January 16, 2002	:	
	:	
For: REACTOR HAVING A MOVABLE	:	
SHUTTER	:	
	:	
	X	

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

DECLARATION UNDER 37 C.F.R. § 1.131

Sir:

1. I, Alex Gurary, am one of the co-inventors with Scott Elman, Keng Moy and Vadim Boguslavskiy of the above-identified pending U.S. Patent Application No. 10/046,426, filed in the United States Patent and Trademark Office on January 16, 2002.

2. I was employed by Emcore Corporation, the original assignee of Application No. 10/046,426, as a Director, Advanced Systems Development during a period from June 1989 through November 2003. In November 2003, the TurboDisc division of Emcore Corporation was purchased by Veeco Instruments Inc. Since that date to the present, I have been employed by Veeco Instruments Inc. as a Director, Advanced Systems Development.

3. On December 23, 2003, Application No. 10/046,426 was assigned from Emcore Corporation to Veeco Instruments Inc. A Patent Assignment for Application No. 10/046,426 was recorded in

the United States Patent and Trademark Office at Reel 014242, Frame 0267, on January 8, 2004. A copy of the Patent Assignment is annexed hereto as Exhibit A.

4. I am aware that Application No. 10/046,426 claims benefit of U.S. Provisional Application Ser. No. 60/296,598, filed June 7, 2001.

5. I invented the subject matter of Application No. 10/046,426, including at least one of the claims therein, with Scott Elman, Keng Moy and Vadim Boguslavskiy, and in accordance with our invention, we reduced the invention to practice prior to May 5, 1999.

6. I am familiar with the prosecution of Application No. 10/046,426, including the Office Action mailed August 23, 2004. In particular, this Office Action includes a rejection based in part upon U.S. Patent Application Publication No. U.S. 2002/0068870 to Noorbakhsh et al. (the '870 published application).

7. I make this Declaration under 37 C.F.R. § 1.131 in order to present a showing of facts establishing a reduction to practice of the invention claimed in Application No. 10/046,426 in this country prior to May 5, 1999, which is the earliest effective filing date of the '870 published application.

8. All of the facts described herein took place in the United States.

9. Annexed hereto is Exhibit B, which is a true copy of an Emcore Patent Disclosure, the date of which has been redacted, but which predates May 5, 1999. The disclosure details

a reactor for epitaxial deposition having a cylindrical shutter with an internal cavity for receiving a coolant, which discloses each and every feature of the reactor as claimed in at least one pending claim of Application No. 10/046,426. As set forth in the patent disclosure, my invention is described as a reactor for growing epitaxial layers including an airtight reaction chamber having a passthrough opening for inserting and removing wafer carriers from the reaction chamber, and a cylindrical shutter located inside the reaction chamber for selectively closing the passthrough opening, the cylindrical shutter being movable between a first position for closing the passthrough opening and a second position for opening the passthrough opening, whereby the cylindrical shutter has an internal cavity adapted to receive a cooling fluid.

10. Annexed hereto is Exhibit C, which is a true copy of an Emcore print, the date of which has been redacted, but which predates May 5, 1999. The print details a cylindrical shutter having an internal cavity for receiving a coolant.

11. Prior to May 5, 1999, we thus invented and actually reduced to practice a reactor for growing epitaxial layers having a cylindrical shutter with an internal cavity adapted to receive a cooling fluid.

12. It is submitted that the foregoing presentation of facts and supporting documentation establishes the completion of Applicants' claimed invention and that such completion predates May 5, 1999.

13. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

9/20/2004
Date

Alex Gurary
ALEXANDER GURARY

Attachments:

- Exhibit A - Merger Document
- Exhibit B - Emcore Corporation Patent Disclosure
- Exhibit C - Emcore Corporation Print

515482_1.DOC

Exhibit A - Merger Document

3.0-069

Docket No.: F53342

FORM PTO-1595 (Modified)
(Rev. 03-01)
OMB No. 0661-0027 (exp. 3/31/2002)
POB/REV03

RECORDATION FORM COVER SHEET

U.S. DEPARTMENT OF COMMERCE
Patent and Trademark Office

PATENTS ONLY

Tab settings → → → ▼ ▼ ▼ ▼ ▼ ▼ ▼

To the Director of the United States Patent and Trademark Office: Please record the attached original documents or copy thereof.

1. Name of conveying party(ies):
EMCORE Corporation

Additional names(s) of conveying party(ies)

☒ Yes ☐ No

3. Nature of conveyance:

☒ Assignment☐ Merger☐ Security Agreement☐ Change of Name☐ OtherExecution Date: **December 22, 2003**

2. Name and address of receiving party(ies):

Name: **Veeco Instruments Inc.**

Internal Address:

Street Address:

City: **Woodbury** State: **NY** ZIP: **11797**Additional name(s) & address(es) attached? ☐ Yes ☒ No

4. Application number(s) or patent numbers(s):

If this document is being filed together with a new application, the execution date of the application is:

A. Patent Application No.(s)

09/619,254 60/514,959
10/046,426
10/304,646
10/268,464

B. Patent No.(s)

4,714,091	5,336,324	5,835,678
4,772,356	5,544,618	6,001,183
4,838,983	5,759,281	6,080,241
4,969,416	5,835,677	6,197,121

Additional numbers attached? ☒ Yes ☐ No

5. Name and address of party to whom correspondence concerning document should be mailed:

Name: **Philip Braginsky**

Internal Address:

Street Address:

City: **Garden City** State: **NY** ZIP: **11530**6. Total number of applications and patents involved: **22**7. Total fee (37 CFR 3.41):.....\$ **880.00**☐ Enclosed - Any excess or insufficiency should be credited or debited to deposit account☒ Authorized to be charged to deposit account

8. Deposit account number:

19-1013

(Attach duplicate copy of this page if paying by deposit account)

DO NOT USE THIS SPACE

9. Statement and signature.

To the best of my knowledge and belief, the foregoing information is true and correct and any attached copy is a true copy of the original document.

Philip Braginsky, 40,527

Name of Person Signing

Signature

January 8, 2004

Date

Total number of pages including cover sheet, attachments, and document: **6**

Mail documents to be recorded with required cover sheet information to:
Mail Stop Assignment Recordation Services
Director of the United States Patent and Trademark Office, P.O. Box 1450
Alexandria, VA 22304-0145

PATENT

700059763

REEL: 014242 FRAME: 0265

CH \$880.00 191013 09619254

Additional patent numbers:

6,368,404
6,349,270
6,492,625
6,506,252
6,547,876

Patent Assignment

WHEREAS, EMCORE Corporation (hereinafter, "Assignor"), a New Jersey corporation with a place of business at 145 Belmont Drive, Somerset, NJ is the owner of rights in certain patents and/or patent applications listed in the attached Schedule, and the inventions disclosed and claimed therein (the "Patents");

WHEREAS, Veeco Instruments Inc. (hereinafter, "Assignee"), a corporation organized and existing under the laws of the State of Delaware with offices at 100 Sunnyside Blvd., Suite B, Woodbury, NY 11797-2902, United States of America, desires to acquire Assignor's entire right, title, and interest in and to the Patents; and

WHEREAS, Assignor and Assignee have entered into an Intellectual Property Agreement pursuant to which Assignor has agreed to assign certain proprietary technology, including the Patents, to Assignee.

NOW THEREFORE, effective immediately by this document, and for good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, Assignor does hereby sell, assign and transfer to Assignee, and its successors and assigns, Assignor's entire right, title, and interest, in the United States and all foreign countries, in the Patents, and all continuations, divisions, extensions, reexaminations, reissues, and substitutes thereof, rights of priority under the International Convention for the Protection of Industrial Property, the Inter-American Convention Relating to Patents, Designs and Industrial Models, and any other international agreements to which the United States adheres, and in and to all income, royalties, damages, claims, and payments now or hereafter due or payable with respect thereto, and in and to all causes of action (either in law or in equity) and the right to sue, counterclaim, and recover for past, present, and future infringement of the rights assigned to Assignee hereunder.

Assignor hereby agrees to execute any papers and to perform such other proper acts as reasonably necessary to secure to Assignee or to its successors or assigns, the rights, title and interest hereby transferred.

WHEREFORE, Assignor has duly executed this Patent Assignment on the date indicated below.

("Assignor")

By:



Howard Bradie
Vice President & General Counsel

Date: December 22, 2003

[STATE OF New Jersey]

COUNTY OF Monmouth)

On this 22 day of December 2003 before me, a Notary Public in and for Monmouth in the State of New Jersey, personally appeared Howard Bradie and being duly sworn, averred that, being duly authorized, he executed the foregoing Assignment as his free and voluntary act for the uses and purposes therein set forth.

NOTARY PUBLIC

My Commission Expires: 5/1/2007]

SILVIA GENTILE
NOTARY PUBLIC OF NEW JERSEY
My Commission Expires May 1, 2007

U.S. Patent No. 6,506,252
Chinese Patent Appln. No. 01822507.1
European Patent Appln. No. 01964250.3
Japanese Patent Appln. No. 2002-562804
Korean Patent Appln. No. 10-2003-7010387

SUSCEPTORLESS REACTOR FOR GROWING
EPITAXIAL LAYERS ON WAFERS BY CVD

U.S. Patent No. 6,547,876

APPARATUS FOR GROWING EPITAXIAL
LAYERS ON WAFERS BY CHEMICAL VAPOR
DEPOSITION

U.S. Patent Appln. No. 09/619,254
European Patent Appln. No. 00952166.7
Japanese Patent Appln. No. 512955/2001
Korean Patent Appln. No. 2002-701052
Taiwan Patent No. NI-154647

APPARATUS FOR GROWING EPITAXIAL
LAYERS ON WAFERS USING LOW PRESSURE
INTERFACE AND METHODS THEREOF

U.S. Patent Appln. No. 10/046,426

REACTOR HAVING A MOVABLE SHUTTER

U.S. Patent Appln. No. 10/304,646
U.S. Patent Appln. No. 10/268,464

SUSCEPTORLESS REACTOR FOR GROWING
EPITAXIAL LAYERS ON WAFERS BY
CHEMICAL VAPOR DEPOSITION

U.S. Patent Appln. No. 09/619,254

APPARATUS FOR GROWING EPITAXIAL
LAYERS ON WAFERS USING LOW PRESSURE
INTERFACE AND METHODS THEREFOR

U.S. Provisional Appln. No. 60/514,959

WAFER CARRIER FOR GROWING GaN
WAFERS

PCT/US03/26112
Taiwan Patent Appln. No. 092125071

ALKYL PUSH FLOW FOR VERTICAL FLOW
ROTATING DISK REACTORS

N/A

METHOD AND DEVICE FOR WAFER AND
CARRIER CONTROL DURING MOCVD OF
GaN RELATED MATERIALS

Patent Schedule

U.S. Patent No. 4,714,091
Japanese Patent No. 1758220

MODULAR GAS HANDLING APPARATUS

U.S. Patent No. 4,772,356
U.S. Patent No. 4,838,983
U.S. Patent No. 4,969,416

GAS TREATMENT APPARATUS AND METHOD

U.S. Patent No. 5,336,324
U.S. Patent No. 5,544,618

APPARATUS FOR DEPOSITING A COATING
ON A SUBSTRATE

U.S. Patent No. 5,759,281

CVD REACTOR FOR UNIFORM HEATING
WITH RADIANT HEATING ELEMENTS

U.S. Patent No. 5,835,677
U.S. Patent No. 5,835,678

LIQUID VAPORIZER SYSTEM AND METHOD

U.S. Patent No. 6,001,183

WAFER CARRIERS FOR EPITAXIAL
GROWTH PROCESSES

U.S. Patent No. 6,080,241

CHEMICAL VAPOR DEPOSITIONS CHAMBER
HAVING AN ADJUSTABLE FLOW FLANGE

U.S. Patent No. 6,197,121

CHEMICAL VAPOR DEPOSITION
APPARATUS

U.S. Patent No. 6,368,404

INDUCTION HEATING CHEMICAL VAPOR
DEPOSITION REACTOR

U.S. Patent No. 6,349,270

METHOD AND APPARATUS FOR
MEASURING THE TEMPERATURE OF
OBJECTS ON A FAST MOVING HOLDER

U.S. Patent No. 6,492,625
Chinese Patent Appln. No. 01819511.3
European Patent Appln. No. 01957492.0
Japanese Patent Appln. No. 2002-530254
Korean Patent Appln. No. 10-2003-7003837

APPARATUS AND METHOD FOR
CONTROLLING TEMPERATURE
UNIFORMITY OF SUBSTRATES

Exhibit B - Emcore Corporation Patent Disclosure

REACTOR FOR HIGH TEMPERATURE EPITAXIAL DEPOSITION

EMCORE Corporation, 145 Belmont Drive, Somerset, NJ 08873

Authors: Keng Moy, Scott Elman, Vadim Boguslavskiy, Alex Gurary

PATENT DISCLOSURE

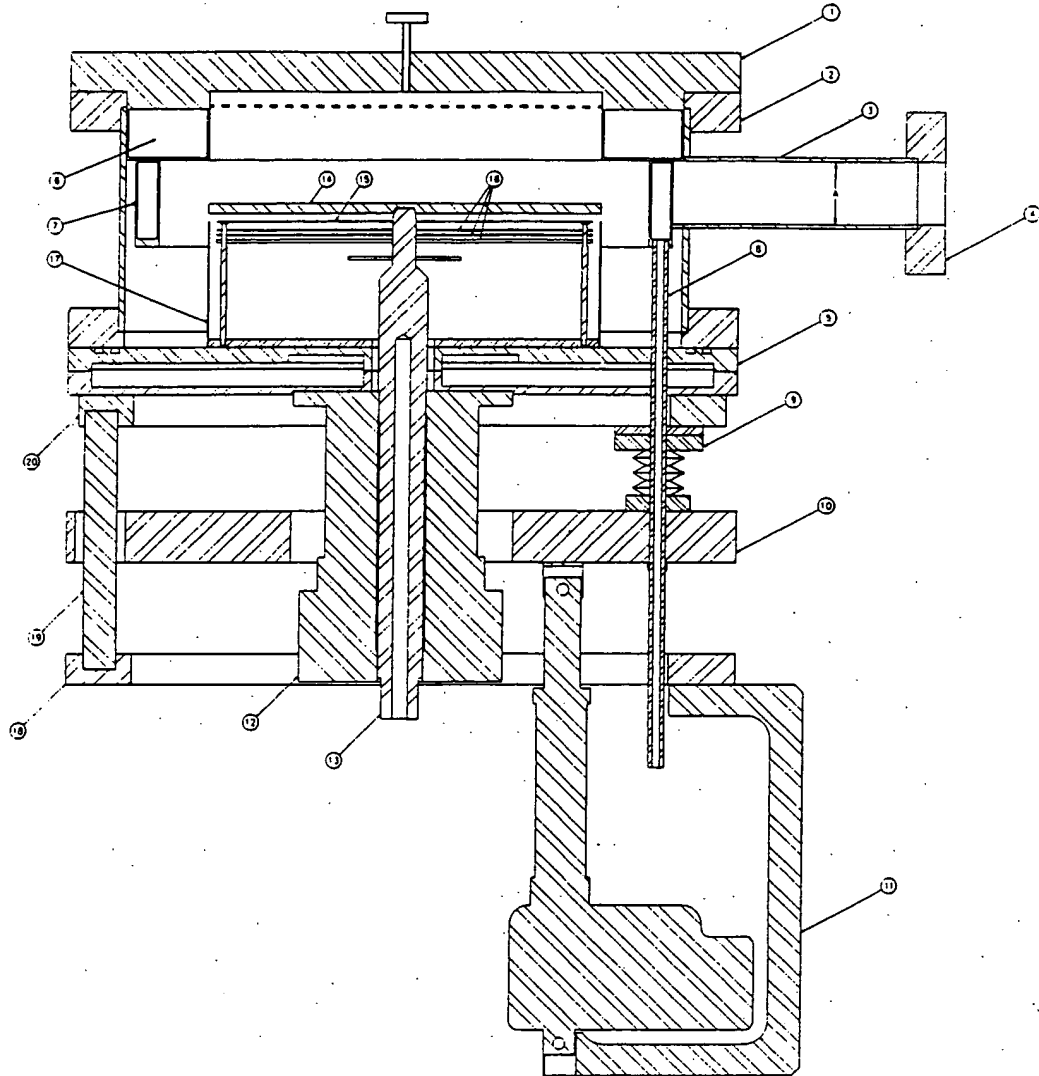


Figure 1. Schematics of the reactor for high temperature epitaxial deposition

Abstract.

Object of the invention is a reactor for high temperature epitaxial deposition with mechanism for wafer carrier transfer in and out reactor which do not produce disturbance in the axisymmetric uniformity of thermal and flow field inside reactor and, hence, provides for extremely uniform epitaxial deposition. Invention is applicable preferably to axisymmetric reactor for epitaxial deposition of SiC (1600 C) and GaN (1100 C). Additionally invention is applicable for epitaxial reactor based on the high speed vertical rotating disk technology.

Background of the invention.

Most of production level epitaxial deposition reactors have a cylindrical shape with opening on the side wall to transfer wafer carriers in and out of the reactor. Opening on the side is connected through the gate valve with load lock which allows the reactor to be open each run while maintaining a low level of contamination in the reactor environment required for the advanced epitaxial deposition. During the deposition run the opening on the wall is covered by the special movable shutter with surface larger than opening to prevent gate valve overheating and particles formation. Unfortunately shutter also provides disturbance in the process flow dynamic (because to provide its movement shutter could not perfectly fit dimensions of the opening in the wall) and disturbance in the reactor thermal dynamic (because heat flow from the shutter is unavoidably different from the wall). Especially significant is thermal disturbance from the shutter in the reactor for high temperature epitaxial deposition (SiC - 1600 C, GaN - 1100 C) where reactor wall are usually water cooled while shutter is not. Because shutter components are logically located approximately on the wafer carrier level, the disturbance from it can have a significant negative effect on the deposition process which is extremely sensitive to uniformity of reactants flow and temperature distribution inside process reactor.

Description of the invention.

Invention is schematically shown (but not limited to) in figure 1. Cylindrical process reactor 2 is made of stainless steel. Reactants are introduced inside reactor 2 through the shower head type water cooled injector flange 1. Water cooled element 6 confine reactants flow to increase deposition efficiency. Wafer carrier 14 with substrates (Si, GaAs, Ge, InP, SiC, sapphire, etc.) for epitaxial deposition can be transferred by special vacuum robot (not shown in figure) through the passthrough 3 with flange 4 connected to gate valve (not shown) that separate reactor environment. Wafer carrier 14 is heated by the radiant heating element(s) 15 which high heating efficiency is provided by three horizontal heat shields 16 and vertical cylindrical heat shield 17. Wafer carrier is supported and spanned by the water cooled spindle 13 sealed from outside by commercially available vacuum rotary feedthrough (in most cases ferrofluidic type) 12 with implemented electrical motor. Process reactor 2 and rotary feedthrough 12 are fixed on water cooled base plate 5.

Passthrough 3 opening is covered by cylindrical shutter 7 with internal cavity for water cooling. Shutter 7 is located on at least two tubing 8 (only one is shown in figure) which is sealed to the reactor based plate 5 using bellow 9. Another end of the tubing 8 is connected to the moveable plate 10 installed using linear motion guide 19 connected through the spacer 20 to the reactor base plate 5. Plate 10 can move up and down by electro-mechanical actuator 11 fixed using stationary plate 18, guide 19, and spacer 20 on the reactor base plate 5. Cooling water is supplied to moveable shutter 7 through the flexible tubing (not shown) connected with the first tube 8, second tube 8 provide for cooling water return.

Movable tubing allows the water cooled shutter 7 to close passthrough 3 opening during epitaxial deposition run. At this time water cooled shutter 7 provides for uniform temperature and flow field around wafer carrier 14 that are required for uniform epitaxial deposition. When deposition run is over, the water cooled shutter 7 is moved down (by force transferred through tubing 8 from electro-mechanical actuator 11) and open passthrough 3 to transfer old carrier 14 from the reactor and new carrier 14 (not shown) in to the reactor.

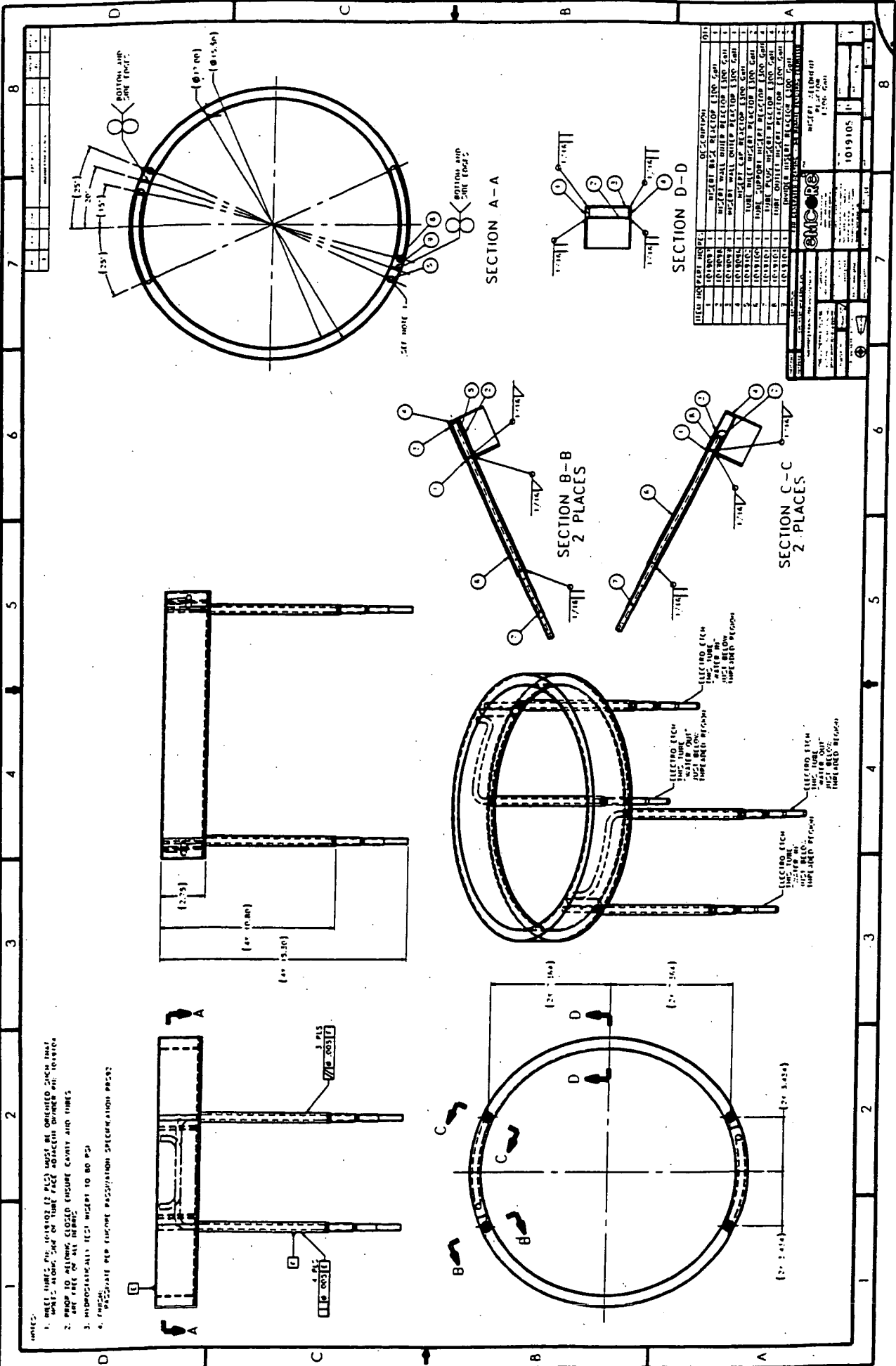
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Water cooled cylindrical shutter was independently suggested and implemented by Alex Gurary and Vadim Boguslavskiy in D75 shell reactor on system 6; and by Keng Moy and Scott Elman in E300 GaN system. No system with water cooled cylindrical shutter was sold so far and this design was not presented in papers or on the conferences.

Why we should apply for this invention:

We will protect IP on new important for EMCORE product – E300 GaN system. We strongly believe that successful implementation of this system is largely due to uniform flow and thermal field achieved because of cylindrical water cooled shutter implementation is this system. In future we can expect use such a shutter on new generation of EMCORE's systems.

Exhibit C - Emcore Corporation Print





PATENT
VEECO 3.0-069

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of :
Gurary et al. :
: Group Art Unit: 1763
Application No. 10/046,426 :
: Examiner: K. Moore
Filed: January 16, 2002 :
: :
For: REACTOR HAVING A MOVABLE :
SHUTTER :
: :
X

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

DECLARATION UNDER 37 C.F.R. § 1.131

Sir:

1. I, Scott Elman, am one of the co-inventors with, Alex Gurary, Keng Moy and Vadim Boguslavskiy of the above-identified pending U.S. Patent Application No. 10/046,426, filed in the United States Patent and Trademark Office on January 16, 2002.

2. I was employed by Emcore Corporation, the original assignee of Application No. 10/046,426, as a Mechanical Designer during a period from April 1991 through November 2003. In November 2003, the TurboDisc division of Emcore Corporation was purchased by Veeco Instruments Inc. Since that date to the present, I have been employed by Veeco Instruments Inc. as a Mechanical Design Engineer.

3. On December 23, 2003, Application No. 10/046,426 was assigned from Emcore Corporation to Veeco Instruments Inc. A Patent Assignment for Application No. 10/046,426 was recorded in

the United States Patent and Trademark Office at Reel 014242, Frame 0267, on January 8, 2004. A copy of the Patent Assignment is annexed hereto as Exhibit A.

4. I am aware that Application No. 10/046,426 claims benefit of U.S. Provisional Application Ser. No. 60/296,598, filed June 7, 2001.

5. I invented the subject matter of Application No. 10/046,426, including at least one of the claims therein, with Scott Elman, Keng Moy and Vadim Boguslavskiy, and in accordance with our invention, we reduced the invention to practice prior to May 5, 1999.

6. I am familiar with the prosecution of Application No. 10/046,426, including the Office Action mailed August 23, 2004. In particular, this Office Action includes a rejection based in part upon U.S. Patent Application Publication No. U.S. 2002/0068870 to Noorbakhsh et al. (the '870 published application).

7. I make this Declaration under 37 C.F.R. § 1.131 in order to present a showing of facts establishing a reduction to practice of the invention claimed in Application No. 10/046,426 in this country prior to May 5, 1999, which is the earliest effective filing date of the '870 published application.

8. All of the facts described herein took place in the United States.

9. Annexed hereto is Exhibit B, which is a true copy of an Emcore Patent Disclosure, the date of which has been redacted, but which predates May 5, 1999. The disclosure details

a reactor for epitaxial deposition having a cylindrical shutter with an internal cavity for receiving a coolant, which discloses each and every feature of the reactor as claimed in at least one pending claim of Application No. 10/046,426. As set forth in the patent disclosure, my invention is described as a reactor for growing epitaxial layers including an airtight reaction chamber having a passthrough opening for inserting and removing wafer carriers from the reaction chamber, and a cylindrical shutter located inside the reaction chamber for selectively closing the passthrough opening, the cylindrical shutter being movable between a first position for closing the passthrough opening and a second position for opening the passthrough opening, whereby the cylindrical shutter has an internal cavity adapted to receive a cooling fluid.


10. Annexed hereto is Exhibit C, which is a true copy of an Emcore print, the date of which has been redacted, but which predates May 5, 1999. The print details a cylindrical shutter having an internal cavity for receiving a coolant.

11. Prior to May 5, 1999, we thus invented and actually reduced to practice a reactor for growing epitaxial layers having a cylindrical shutter with an internal cavity adapted to receive a cooling fluid.

12. It is submitted that the foregoing presentation of facts and supporting documentation establishes the completion of Applicants' claimed invention and that such completion predates May 5, 1999.

13. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

9/20/04
Date


SCOTT ELMAN

Attachments:

- Exhibit A - Merger Document
- Exhibit B - Emcore Corporation Patent Disclosure
- Exhibit C - Emcore Corporation Print

515490_1.DOC

Exhibit A - Merger Document

3.0-069

Docket No.: F53342

FORM PTO-1595 (Modified)
(Rev. 03-01)
OMB No. 0861-0027 (exp. 3/31/2002)
P08/REV03

RECORDATION FORM COVER SHEET

U.S. DEPARTMENT OF COMMERCE
Patent and Trademark Office

PATENTS ONLY

Tab settings → → → ▼ ▼ ▼ ▼ ▼ ▼ ▼

To the Director of the United States Patent and Trademark Office: Please record the attached original documents or copy thereof.

1. Name of conveying party(ies):
EMCORE Corporation

Additional names(s) of conveying party(ies)

☒ Yes ☐ No

3. Nature of conveyance:

- ☒ Assignment ☐ Merger
☐ Security Agreement ☐ Change of Name
☐ Other _____

Execution Date: **December 22, 2003**

2. Name and address of receiving party(ies):

Name: **Veeco Instruments Inc.**

Internal Address: _____

Street Address: _____

City: **Woodbury** State: **NY** ZIP: **11797**Additional name(s) & address(es) attached? ☐ Yes ☒ No

4. Application number(s) or patent numbers(s):

If this document is being filed together with a new application, the execution date of the application is: _____

A. Patent Application No.(s)

09/619,254 60/514,959
10/046,426
10/304,646
10/268,464

B. Patent No.(s)

4,714,091	5,336,324	5,835,678
4,772,356	5,544,618	6,001,183
4,838,983	5,759,281	6,080,241
4,969,416	5,835,677	6,197,121

Additional numbers attached? ☒ Yes ☐ No

5. Name and address of party to whom correspondence concerning document should be mailed:

Name: **Philip Braginsky**

Internal Address: _____

Street Address: _____

City: **Garden City** State: **NY** ZIP: **11530**6. Total number of applications and patents involved: **22**7. Total fee (37 CFR 3.41):.....\$ **880.00**☐ Enclosed - Any excess or insufficiency should be credited or debited to deposit account☒ Authorized to be charged to deposit account

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To the best of my knowledge and belief, the foregoing information is true and correct and any attached copy is a true copy of the original document.

Philip Braginsky, 40,527

Name of Person Signing

Signature

January 8, 2004

Date

Total number of pages including cover sheet, attachments, and document: **6**

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PATENT

700059763

REEL: 014242 FRAME: 0265

CH \$880.00 191013 09619254

Additional patent numbers:

6,368,404

6,349,270

6,492,625

6,506,252

6,547,876

Patent Assignment

WHEREAS, EMCORE Corporation (hereinafter, "Assignor"), a New Jersey corporation with a place of business at 145 Belmont Drive, Somerset, NJ is the owner of rights in certain patents and/or patent applications listed in the attached Schedule, and the inventions disclosed and claimed therein (the "Patents");

WHEREAS, Veeco Instruments Inc. (hereinafter, "Assignee"), a corporation organized and existing under the laws of the State of Delaware with offices at 100 Sunnyside Blvd., Suite B, Woodbury, NY 11797-2902, United States of America, desires to acquire Assignor's entire right, title, and interest in and to the Patents; and

WHEREAS, Assignor and Assignee have entered into an Intellectual Property Agreement pursuant to which Assignor has agreed to assign certain proprietary technology, including the Patents, to Assignee.

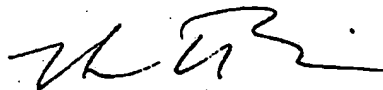
NOW THEREFORE, effective immediately by this document, and for good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, Assignor does hereby sell, assign and transfer to Assignee, and its successors and assigns, Assignor's entire right, title, and interest, in the United States and all foreign countries, in the Patents, and all continuations, divisions, extensions, reexaminations, reissues, and substitutes thereof, rights of priority under the International Convention for the Protection of Industrial Property, the Inter-American Convention Relating to Patents, Designs and Industrial Models, and any other international agreements to which the United States adheres, and in and to all income, royalties, damages, claims, and payments now or hereafter due or payable with respect thereto, and in and to all causes of action (either in law or in equity) and the right to sue, counterclaim, and recover for past, present, and future infringement of the rights assigned to Assignee hereunder.

Assignor hereby agrees to execute any papers and to perform such other proper acts as reasonably necessary to secure to Assignee or to its successors or assigns, the rights, title and interest hereby transferred.

WHEREFORE, Assignor has duly executed this Patent Assignment on the date indicated below.

("Assignor")

By:



Howard Brodie
Vice President & General Counsel

Date: December 22, 2003

[STATE OF New Jersey]

COUNTY OF Monmouth)

On this 22 day of December 2003 before me, a Notary Public in and for Monmouth in the State of New Jersey, personally appeared Howard Brodie and being duly sworn, averred that, being duly authorized, he executed the foregoing Assignment as his free and voluntary act for the uses and purposes therein set forth.

NOTARY PUBLIC

My Commission Expires: 5/1/2007]

SILVIA GENTILE
NOTARY PUBLIC OF NEW JERSEY
My Commission Expires May 1, 2007

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PATENT
REEL: 014242 FRAME: 0268

U.S. Patent No. 6,506,252
Chinese Patent Appln. No. 01822507.1
European Patent Appln. No. 01964250.3
Japanese Patent Appln. No. 2002-562804
Korean Patent Appln. No. 10-2003-7010387

SUSCEPTORLESS REACTOR FOR GROWING
EPITAXIAL LAYERS ON WAFERS BY CVD

U.S. Patent No. 6,547,876

APPARATUS FOR GROWING EPITAXIAL
LAYERS ON WAFERS BY CHEMICAL VAPOR
DEPOSITION

U.S. Patent Appln. No. 09/619,254
European Patent Appln. No. 00952166.7
Japanese Patent Appln. No. 512955/2001
Korean Patent Appln. No. 2002-701052
Taiwan Patent No. NI-154647

APPARATUS FOR GROWING EPITAXIAL
LAYERS ON WAFERS USING LOW PRESSURE
INTERFACE AND METHODS THEREOF

U.S. Patent Appln. No. 10/046,426

REACTOR HAVING A MOVABLE SHUTTER

U.S. Patent Appln. No. 10/304,646
U.S. Patent Appln. No. 10/268,464

SUSCEPTORLESS REACTOR FOR GROWING
EPITAXIAL LAYERS ON WAFERS BY
CHEMICAL VAPOR DEPOSITION

U.S. Patent Appln. No. 09/619,254

APPARATUS FOR GROWING EPITAXIAL
LAYERS ON WAFERS USING LOW PRESSURE
INTERFACE AND METHODS THEREFOR

U.S. Provisional Appln. No. 60/514,959

WAFER CARRIER FOR GROWING GaN
WAFERS

PCT/US03/26112
Taiwan Patent Appln. No. 092125071

ALKYL PUSH FLOW FOR VERTICAL FLOW
ROTATING DISK REACTORS

N/A

METHOD AND DEVICE FOR WAFER AND
CARRIER CONTROL DURING MOCVD OF
GaN RELATED MATERIALS

Patent Schedule

U.S. Patent No. 4,714,091
Japanese Patent No. 1758220

MODULAR GAS HANDLING APPARATUS

U.S. Patent No. 4,772,356
U.S. Patent No. 4,838,983
U.S. Patent No. 4,969,416

GAS TREATMENT APPARATUS AND METHOD

U.S. Patent No. 5,336,324
U.S. Patent No. 5,544,618

APPARATUS FOR DEPOSITING A COATING
ON A SUBSTRATE

U.S. Patent No. 5,759,281

CVD REACTOR FOR UNIFORM HEATING
WITH RADIANT HEATING ELEMENTS

U.S. Patent No. 5,835,677
U.S. Patent No. 5,835,678

LIQUID VAPORIZER SYSTEM AND METHOD

U.S. Patent No. 6,001,183

WAFER CARRIERS FOR EPITAXIAL
GROWTH PROCESSES

U.S. Patent No. 6,080,241

CHEMICAL VAPOR DEPOSITIONS CHAMBER
HAVING AN ADJUSTABLE FLOW FLANGE

U.S. Patent No. 6,197,121

CHEMICAL VAPOR DEPOSITION
APPARATUS

U.S. Patent No. 6,368,404

INDUCTION HEATING CHEMICAL VAPOR
DEPOSITION REACTOR

U.S. Patent No. 6,349,270

METHOD AND APPARATUS FOR
MEASURING THE TEMPERATURE OF
OBJECTS ON A FAST MOVING HOLDER

U.S. Patent No. 6,492,625
Chinese Patent Appln. No. 01819511.3
European Patent Appln. No. 01957492.0
Japanese Patent Appln. No. 2002-530254
Korean Patent Appln. No. 10-2003-7003837

APPARATUS AND METHOD FOR
CONTROLLING TEMPERATURE
UNIFORMITY OF SUBSTRATES

Exhibit B - Emcore Corporation Patent Disclosure

REACTOR FOR HIGH TEMPERATURE EPITAXIAL DEPOSITION

EMCORE Corporation, 145 Belmont Drive, Somerset, NJ 08873

Authors: Keng Moy, Scott Elman, Vadim Boguslavskiy, Alex Gurary

PATENT DISCLOSURE

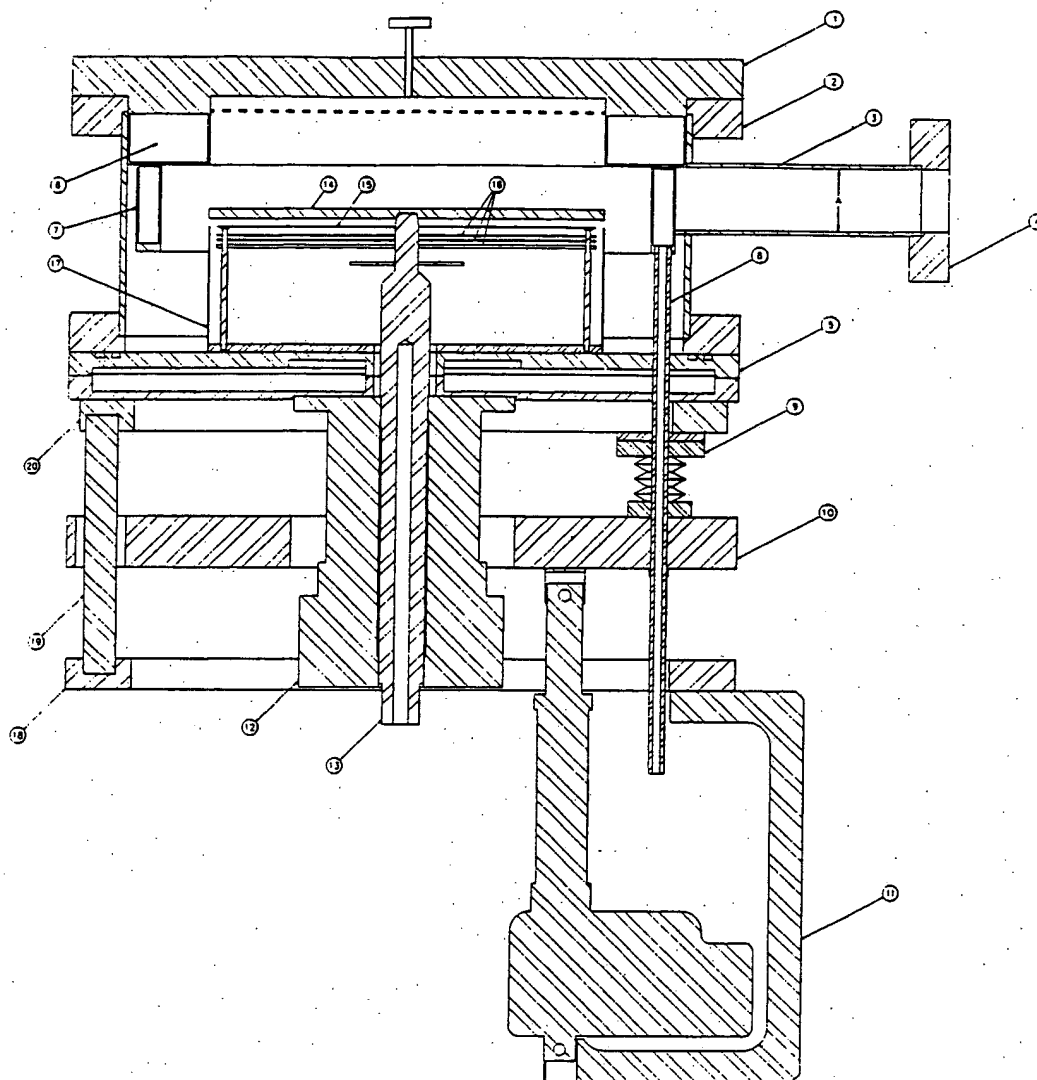


Figure 1. Schematics of the reactor for high temperature epitaxial deposition

Abstract.

Object of the invention is a reactor for high temperature epitaxial deposition with mechanism for wafer carrier transfer in and out reactor which do not produce disturbance in the axisymmetric uniformity of thermal and flow field inside reactor and, hence, provides for extremely uniform epitaxial deposition. Invention is applicable preferably to axisymmetric reactor for epitaxial deposition of SiC (1600 C) and GaN (1100 C). Additionally invention is applicable for epitaxial reactor based on the high speed vertical rotating disk technology.

Background of the invention.

Most of production level epitaxial deposition reactors have a cylindrical shape with opening on the side wall to transfer wafer carriers in and out of the reactor. Opening on the side is connected through the gate valve with load lock which allows the reactor to be open each run while maintaining a low level of contamination in the reactor environment required for the advanced epitaxial deposition. During the deposition run the opening on the wall is covered by the special movable shutter with surface larger than opening to prevent gate valve overheating and particles formation. Unfortunately shutter also provides disturbance in the process flow dynamic (because to provide its movement shutter could not perfectly fit dimensions of the opening in the wall) and disturbance in the reactor thermal dynamic (because heat flow from the shutter is unavoidably different from the wall). Especially significant is thermal disturbance from the shutter in the reactor for high temperature epitaxial deposition (SiC - 1600 C, GaN - 1100 C) where reactor wall are usually water cooled while shutter is not. Because shutter components are logically located approximately on the wafer carrier level, the disturbance from it can have a significant negative effect on the deposition process which is extremely sensitive to uniformity of reactants flow and temperature distribution inside process reactor.

Description of the invention.

Invention is schematically shown (but not limited to) in figure 1. Cylindrical process reactor 2 is made of stainless steel. Reactants are introduced inside reactor 2 through the shower head type water cooled injector flange 1. Water cooled element 6 confine reactants flow to increase deposition efficiency. Wafer carrier 14 with substrates (Si, GaAs, Ge, InP, SiC, sapphire, etc.) for epitaxial deposition can be transferred by special vacuum robot (not shown in figure) through the passthrough 3 with flange 4 connected to gate valve (not shown) that separate reactor environment. Wafer carrier 14 is heated by the radiant heating element(s) 15 which high heating efficiency is provided by three horizontal heat shields 16 and vertical cylindrical heat shield 17. Wafer carrier is supported and spanned by the water cooled spindle 13 sealed from outside by commercially available vacuum rotary feedthrough (in most cases ferrofluidic type) 12 with implemented electrical motor. Process reactor 2 and rotary feedthrough 12 are fixed on water cooled base plate 5.

Passthrough 3 opening is covered by cylindrical shutter 7 with internal cavity for water cooling. Shutter 7 is located on at least two tubing 8 (only one is shown in figure) which is sealed to the reactor based plate 5 using bellow 9. Another end of the tubing 8 is connected to the moveable plate 10 installed using linear motion guide 19 connected through the spacer 20 to the reactor base plate 5. Plate 10 can move up and down by electro-mechanical actuator 11 fixed using stationary plate 18, guide 19, and spacer 20 on the reactor base plate 5. Cooling water is supplied to moveable shutter 7 through the flexible tubing (not shown) connected with the first tube 8, second tube 8 provide for cooling water return.

Movable tubing allows the water cooled shutter 7 to close passthrough 3 opening during epitaxial deposition run. At this time water cooled shutter 7 provides for uniform temperature and flow field around wafer carrier 14 that are required for uniform epitaxial deposition. When deposition run is over, the water cooled shutter 7 is moved down (by force transferred through tubing 8 from electro-mechanical actuator 11) and open passthrough 3 to transfer old carrier 14 from the reactor and new carrier 14 (not shown) in to the reactor.

History of the invention:

Water cooled cylindrical shutter was independently suggested and implemented by Alex Gurary and Vadim Boguslavskiy in D75 shell reactor on system 6; and by Keng Moy and Scott Elman in E300 GaN system. No system with water cooled cylindrical shutter was sold so far and this design was not presented in papers or on the conferences.

Why we should apply for this invention:

We will protect IP on new important for EMCORE product – E300 GaN system. We strongly believe that successful implementation of this system is largely due to uniform flow and thermal field achieved because of cylindrical water cooled shutter implementation in this system. In future we can expect use such a shutter on new generation of EMCORE's systems.

Exhibit C - Emcore Corporation Print

